UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION III
1650 Arch Street
Philadelphia, Pennsylvania 19103-2029

Mr. Larry Lawson, Director
Division of Water Program Coordination
Virginia Department of Environmental Quality
629 Main Street
Richmond, VA 23219

Dear Mr. Lawson:

The Environmental Protection Agency (EPA) Region III is pleased to approve the Total Maximum Daily Load (TMDL) report for the primary contact use (bacteria) impairment on Reed Creek. The TMDL report was submitted to EPA for review in April 2004. The TMDL was established and submitted in accordance with Section 303(d)(1)(c) and (2) of the Clean Water Act to address an impairment of water quality as identified in Virginia's 1998 Section 303(d) list.

In accordance with Federal regulations at 40 CFR §130.7, a TMDL must comply with the following requirements: (1) designed to attain and maintain the applicable water quality standards, (2) include a total allowable loading and as appropriate, wasteload allocations (WLAs) for point sources and load allocations for nonpoint sources, (3) consider the impacts of background pollutant contributions, (4) take critical stream conditions into account (the conditions when water quality is most likely to be violated), (5) consider seasonal variations, (6) include a margin of safety (which accounts for uncertainties in the relationship between pollutant loads and instream water quality), (7) consider reasonable assurance that the TMDL can be met, and (8) be subject to public participation. The enclosure to this letter describes how the TMDL for the primary contact use impairment satisfies each of these requirements.

Following the approval of the TMDL, Virginia shall incorporate the TMDL into an appropriate Water Quality Management Plan pursuant to 40 CFR § 130.7(d)(2). As you know, all new or revised National Pollutant Discharge Elimination System permits must be consistent with the TMDL WLA pursuant to 40 CFR §122.44 (d)(1)(vii)(B). Please submit all such permits to EPA for review as per EPA's letter dated October 1, 1998.

If you have any questions or comments concerning this letter, please don't hesitate to contact Mr. Thomas Henry at (215) 814-5752.

Sincerely,

Jon M. Capacasa, Director
Water Protection Division

Enclosure

Decision Rationale

Total Maximum Daily Load for
the Primary Contact Use (Bacteriological) Impairment on Reed Creek

I. Introduction

The Clean Water Act (CWA) requires a Total Maximum Daily Load (TMDL) be developed for those water bodies identified as impaired by a state where technology-based and other controls will not provide for attainment of water quality standards. A TMDL is a determination of the amount of a pollutant from point, nonpoint, and natural background sources, including a margin of safety (MOS), that may be discharged to a water quality-limited water body.

This document will set forth the Environmental Protection Agency's (EPA's) rationale for approving the TMDL for the primary contact use (bacteriological) impairment on Reed Creek. EPA's rationale is based on the determination that the TMDL meets the following eight regulatory conditions pursuant to 40 CFR §130.

1) The TMDL is designed to implement applicable water quality standards.
2) The TMDL includes a total allowable load as well as individual waste load allocations and load allocations.
3) The TMDL considers the impacts of background pollutant contributions.
4) The TMDL considers critical environmental conditions.
5) The TMDL considers seasonal environmental variations.
6) The TMDL includes a margin of safety.
7) There is reasonable assurance that the TMDL can be met.
8) The TMDL has been subject to public participation.

II. Background

The Reed Creek Watershed is located in Bedford County, Virginia. The watershed is 14,800 acres in size. The 12.27 mile impairment runs from the headwaters of Reed Creek to its confluence with the James River. The Reed Creek Watershed is rural, with approximately 99 percent of the watershed composed of forested (78 percent) and agricultural (21 percent) lands. The remainder of the watershed is composed of residential developments, transitional lands, and wetlands.

In response to Section 303(d) of the CWA, the Virginia Department of Environmental Quality (VADEQ) listed 12.27 miles of Reed Creek (VAW-H01R) on Virginia's 1998 Section 303(d) list as being unable to attain its primary contact use due to violations of the bacteriological criteria. This decision rationale will address the TMDL for the primary contact use impairment on Reed Creek.

Reed Creek was listed for violations of Virginia's fecal coliform water quality criteria. Fecal coliform is a bacterium which can be found within the intestinal tract of all warm blooded animals. Therefore, fecal coliform can be found in the fecal wastes of all warm blooded animals. Fecal coliform in itself is not a pathogenic organism. Its presence indicates the potential for the existence of other pathogenic bacteria. The higher concentrations of fecal coliform indicate the elevated likelihood of increased pathogenic organisms.

EPA has been encouraging the states to use e-coli and enterococci as the indicator species instead of fecal coliform. A better correlation has been drawn between the concentrations of e-coli and enterococci, and the incidence of gastrointestinal illness. The Commonwealth adopted e-coli and enterococci criteria in 2002. Streams are evaluated via the e-coli and enterococci criteria after 12 samples have been collected using these indicator species. At least12 e-coli samples have been collected from Reed Creek. Therefore, compliance with the primary contact use is now based upon the e-coli criteria.

As Virginia designates all of its waters for primary contact, all waters must meet the current bacteriological criteria to support this use. Virginia's standard applies to all streams designated for primary contact for all flows. The new e-coli criteria requires a geometric mean concentration of 126 colony forming units (cfu)/100mL of water with no sample exceeding 235 cfu/100mL of water. Unlike the fecal coliform criteria which now allows for a 10% violation rate the new e-coli criteria requires the concentration of e-coli not exceed 235 cfu/100mL of water. Although, the TMDL and criteria require that the standard not be exceeded waters are not placed on the Section 303(d) list if their violation rate does not exceed 10%.

The TMDL submitted by Virginia is designed to determine the acceptable load of e-coli which can be delivered to the impaired water, as demonstrated by the load-duration approach. The load-duration approach is considered an appropriate method for this analysis. The load duration approach analyzes the impaired segment through the analysis and comparison of observed flows, in-stream bacteria concentrations, and the numeric water quality criteria.

The load-duration approach analyzes the stream's entire flow record to find a correlation between flow regimes and bacteriological concentrations. The load-duration approach uses flow data collected by a local gaging station, in this instance the United States Geological Survey (USGS) gage 02027500 was used for the TMDL development process. This gage is located on Piney River, which is in the same hydrologic unit code as Reed Creek. Sixteen grab flow samples were collected from Reed Creek. Six of these samples were taken from 1981 through 1984 the remaining nine samples were collected from March 2002 through July 2003. A regression analysis was drawn between the observed flow data at the USGS gage on Piney River and grab flow samples taken from Reed Creek. The regression analysis indicated a strong correlation with an R value of 0.91. The watersheds also had similar drainage areas, elevations, and ecoregions.

The flow data from Reed Creek was entered into an Excel spreadsheet along with daily

mean flow data from several continuous record gaging stations.[1] Using Excel data analysis tools the impaired watershed's flow was correlated to the observed data from the various USGS gages. Piney River was chosen as the reference watershed because it had a high R value and had similar watershed characteristics to Reed Creek. The flow data from the impaired water was plotted against the daily mean flow data from USGS gage 02027500. Excel plotted a best fit line through the data and developed a regression equation for the relationship. Once the regression equation was developed, a flow for the impaired watershed could be ascertained for any flow observed at gage 02027500 by simply placing that flow through the equation.

The next step of the TMDL was to determine what organisms or sources are responsible for the pollutant loading to the stream. Since fecal coliform is associated with warm blooded animals as mentioned above, it was necessary to determine which animals were providing the bacteria loadings to Reed Creek. Through a process known as bacterial source tracking (BST), VADEQ was able to breakdown the sources of bacteria into four categories. The four categories were human, pets, livestock, and wildlife. Three of these four sources are anthropogenic in origin and can be controlled through a variety of management techniques. Wildlife, which may be attracted to certain areas due to anthropogenic reasons, is considered a natural source of bacteria.

The BST approach used by VADEQ is known as the Antibiotic Resistance Approach (ARA) it measures the bacteria's resistance to a suite of antibiotics. The assumption is that different sources of bacteria will have different resistance patterns to antibiotics. In order to conduct this work waste samples from known sources had to have their resistance measured. This information was then placed into a library. To determine the sources of the bacteria collected in water samples from Reed Creek, the resistance patterns of these unknown sources were compared to the results established in the library. For additional information of the ARA, please refer to Appendix B of the TMDL.

The data collected in steps one and two were then combined to determine the impact of the various sources to water quality in Reed Creek. VADEQ collected one year of BST samples from the water. For each sample, VADEQ determined the bacterial concentration and the percent loading derived from each source. The percent loading for each source category was averaged over the annual period. The average annual percent loading was used to determine the loading for each source. This was done by multiplying the average annual percent loading by the average annual loading.

In Reed Creek, the highest bacteria violation occurred during a flow around 77 cubic feet per second,15% of Reed Creek's flows are expected to exceed this flow. The e-coli load for this flow event was 2.63E+15 cfu/year. This was determined by multiplying the concentration by the total volume by 365 days. The allowable load at this same flow was 1.62E+14 cfu/year. This

[1]VADEQ, March 2004, "Bacteria TMDLs for Sepulcher Creek, Toms Creek, Little Toms Creek and Crab Orchard Branch

represents a 94 percent reduction in loadings. Next the average annual flow was determined for Reed Creek and the same magnitude violation was applied to that flow. A 94 percent load reduction, percent reduction based on largest violation, was then applied to the e-coli load associated with this flow event. The BST data demonstrated that livestock, pets, humans, and wildlife represented 38, 16, 2, and 40 percent of the load respectively. It was determined that all sources must be reduced. The high livestock and wildlife loadings conform with a watershed dominated by forested and agricultural lands.

Through the development of this and other similar TMDLs, it was discovered that natural conditions (wildlife contributions to the streams) could cause or contribute to violations of the bacteria criteria. BST sampling data collected on Reed Creek indicated that bacteria from wildlife represents approximately 40 percent of the load. Many of Virginia's TMDLs, including the TMDL for Reed Creek, have called for some reduction in the amount of wildlife contributions to the impacted streams. EPA believes that a significant reduction in wildlife is not practical and will not be necessary due to the implementation plan discussed below. It should be noted that in order for Reed Creek to be in compliance greater than 90 percent of time, a 70 percent load reduction is required. Also, the magnitude of the bacterial violations on Reed Creek have gone down over the last three years 2001 through 2004. The TMDL evaluated all of the sampling data, the largest violation observed was from a sample collected in 1994. Based on the last three years of data, a 50 percent reduction in loading is necessary.

A phased implementation plan will be developed for all streams in which the TMDL calls for reductions in wildlife. In Phase 1 of the implementation, the Commonwealth will begin implementing the reductions (other than wildlife) called for in the TMDL. In Phase 2, which can occur concurrently to Phase 1, the Commonwealth will consider addressing its standards to accommodate this natural loading condition. The Commonwealth has indicated that during Phase 2, it may develop a Use Attainability Analysis (UAA) for streams with wildlife reductions which are not used for frequent bathing. Depending upon the result of the UAA, it is possible that these streams could be designated for secondary contact.

After the completion of Phase 1 of the implementation plan, the Commonwealth will monitor the stream to determine if the wildlife reductions are actually necessary, as the violation level associated with the wildlife loading may be smaller than the percent error of the model. In Phase 3, the Commonwealth will investigate the sampling data to determine if further load reductions are needed in order for these waters to attain standards. If the load reductions and/or the new application of standards allow the stream to attain standards, then no additional work is warranted. However, if standards are still not being attained after the implementation of Phases 1 and 2, further work and reductions will be warranted.

Table 1 - Summarizes the Specific Elements of the TMDL.

Segment	Parameter	TMDL (cfu/yr)	WLA (cfu/yr)	LA (cfu/yr)	MOS

Reed Creek	E-Coli	9.71E+13	0.0	9.71E+13	Implicit

The United States Fish and Wildlife Service has been provided with copy of this TMDL.

III. Discussion of Regulatory Conditions

EPA finds that Virginia has provided sufficient information to meet all of the eight basic requirements for establishing a primary contact (bacteriological) impairment TMDL for Reed Creek. EPA is therefore approving this TMDL. EPA's approval is outlined according to the regulatory requirements listed below.

1) The TMDL is designed to meet the applicable water quality standards.

Virginia has indicated that excessive levels of bacteria from both anthropogenic and natural sources have caused violations of the water quality criteria and designated uses in the Reed Creek Watershed. The water quality criterion for fecal coliform was a geometric mean 200 cfu/100mL or an instantaneous standard of no more than 1,000 cfu/100ml. Two or more samples over a thirty-day period are required for the geometric mean standard. The Commonwealth has changed its bacteriological criteria as indicated above. The new e-coli criteria require a geometric mean of 126 cfu/100mL of water with no sample exceeding 235 cfu/100 ml.

The load-duration approach, described above, was used by the Commonwealth for the development of the Reed Creek TMDL. This approach uses the flow data from a USGS gage, in-stream water quality data, a regression equation, and BST data to quantify the bacteria loading and the sources responsible for that loading. The load-duration approach in this instance developed a flow record for the impaired reach based on observed flow data on Piney River. For each flow along the load-duration curve, the allowable load can be determined by multiplying the instantaneous criteria by the flow. The observed loads were determined by multiplying the observed concentrations by the flow that was observed at that time. In order to insure that the TMDL was protective of all flow conditions, it was developed for the flow that exhibited the greatest difference between the observed and allowable loadings. This reduction was then applied to the average annual load which was determined by multiplying the average annual flow by the bacterial concentration observed at the largest violation.

Through the use of BST, VADEQ was able to breakdown the sources of bacteria into four categories. The four source categories were human, pets, livestock, and wildlife. Three of these four sources are anthropogenic in origin and can be controlled through a variety of techniques. Wildlife, which may be attracted to certain areas due to anthropogenic reasons, is considered a natural source of bacteria.

VADEQ collected one year of BST samples from the water. VADEQ determined the bacterial concentration and the percent loading derived from each source for each sample. The percent loading for each source category was averaged over the annual period. This average percent loading was used to determine the loading for each source.

2) The TMDL includes a total allowable load as well as individual waste load allocations and load allocations.

Total Allowable Loads

Virginia indicates that the total allowable loading is the sum of the loads allocated to land based precipitation driven nonpoint source areas (forest and agricultural land segments) and point sources. Activities that increase the levels of bacteria to the land surface or their availability to runoff are considered flux sources. The actual value for total loading can be found in Table 1 of this document. The total allowable load is calculated on an annual basis.

Waste Load Allocations

There are no regulated point sources of bacteria in the Reed Creek Watershed. Therefore, a waste load allocation (WLA) was not developed for this TMDL. If there was a regulated discharger of e-coli in the watershed, its loadings would require a WLA.

EPA regulations require that an approvable TMDL include individual WLAs for each point source. According to 40 CFR 122.44(d)(1)(vii)(B), "Effluent limits developed to protect a narrative water quality criterion, a numeric water quality criterion, or both, are consistent with assumptions and requirements of any available WLA for the discharge prepared by the state and approved by EPA pursuant to 40 CFR 130.7." Furthermore, EPA has authority to object to the issuance of any National Pollutant Discharge Elimination System (NPDES) permit that is inconsistent with the WLAs established for that point source.

Load Allocations

According to Federal regulations at 40 CFR 130.2(g), load allocations (LAs) are best estimates of the loading, which may range from reasonably accurate estimates to gross allotments, depending on the availability of data and appropriate techniques for predicting loading. Wherever possible, natural and nonpoint source loads should be distinguished.

The load-duration approach used BST data to determine the bacterial loadings from each source category. According to the BST data livestock, pets, humans, and wildlife were responsible for 38, 16, 2 and 40 percent of the load respectively. Table 2 documents the bacteria loading by source category. Based on the BST data, the human load to Reed Creek is very low, in most samples bacteria from human origin were not detected.

Table 2 - Bacterial LAs for Reed Creek

Source Category	Existing Load (cfu/yr)	Proposed Load (cfu/yr)	Percent Reduction
Livestock	6.13E+14	6.13E+12	99
Pets	2.50E+14	2.50E+12	99

Human	1.90E+13	1.90E+11	99
Wildlife	6.98E+14	8.80E+13	87

3) The TMDL considers the impacts of background pollution.

The TMDL considers the impact of background pollutants by considering the bacterial load from natural sources such as wildlife.

4) The TMDL considers critical environmental conditions.

According to EPA's regulation 40 CFR 130.7 (c)(1), TMDLs are required to take into account critical conditions for stream flow, loading, and water quality parameters. The intent of this requirement is to ensure that the water quality of the impaired creek is protected during times when it is most vulnerable.

Critical conditions are important because they describe the factors that combine to cause a violation of water quality standards and will help in identifying the actions that may have to be undertaken to meet water quality standards[2]. Critical conditions are a combination of environmental factors (e.g., flow, temperature, etc.), which have an acceptably low frequency of occurrence. In specifying critical conditions in the waterbody, an attempt is made to use a reasonable "worst-case" scenario condition. This was addressed in the Reed Creek TMDL by modeling the reductions to the flow that exhibited the greatest disparity between observed and allowable concentrations and requiring the reductions needed to attain the criteria under these conditions to average annual conditions.

5) The TMDL considers seasonal environmental variations.

Seasonal variations involve changes in stream flow and loadings as a result of hydrologic and climatological patterns. The loadings to Reed Creek were investigated on a monthly basis to determine if seasonality existed between the sources. Based on the BST results, it was determined that there were minimal seasonal impacts to loading and the source loads were averaged on an annual basis.

6) The TMDL includes a margin of safety.

This requirement is intended to add a level of safety to the modeling process to account for any uncertainty. The MOS may be implicit, built into the modeling process by using conservative modeling assumptions, or explicit, taken as a percentage of the WLA, LA, or

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[2]EPA memorandum regarding EPA Actions to Support High Quality TMDLs from Robert H. Wayland III, Director, Office of Wetlands, Oceans, and Watersheds to the Regional Management Division Directors, August 9, 1999.

TMDL. Virginia included an implicit MOS in the TMDL through the use of conservative modeling assumptions. The Reed Creek TMDL was modeled to the single-most extreme water quality violation event, which occurred over 10 years ago, and applied the reductions necessary during that event to all conditions.

7) There is a reasonable assurance that the TMDL can be met.

EPA requires that there be a reasonable assurance that the TMDL can be implemented. WLAs will be implemented through the NPDES permit process. According to 40 CFR 122.44(d)(1)(vii)(B), the effluent limitations for an NPDES permit must be consistent with the assumptions and requirements of any available WLA for the discharge prepared by the state and approved by EPA. Furthermore, EPA has authority to object to issuance of an NPDES permit that is inconsistent with WLAs established for that point source.

Nonpoint source controls to achieve LAs can be implemented through a number of existing programs such as Section 319 of the CWA, commonly referred to as the Nonpoint Source Program. As stated above, if the last four years of bacteria data were used, the reductions would have been much less as the bacteria concentrations in these samples were much lower.

8) The TMDL has been subject to public participation.

The TMDL was subject to the Commonwealth's public participation process. The meeting and comment period for this TMDL were noticed in the Virginia Register. There was a public meeting held on March 18, 2004 in Sedalia, VA. No comments were received by VADEQ during the thirty-day comment period.